QUALITY EVALUATION LABORATORY
UNITED STATES NAVAL AMMUNITION DEPOT
CRANE, INDIANA

EVALUATION PROGRAM
FOR
SECONDARY SPACECRAFT CELLS

ACCEPTANCE TEST
OF
SVENSKA ACKUMULATOR AKTIEBOLAGET JUNGNER OF SWEDEN
3.9 AMPERE-HOUR NICKEL-CADMIUM CELLS

QE/C 67-681

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Enclosure (1)

REPORT BRIEF

JUNGNER OF SWEDEN 3.9 AMPERE-HOUR SEALED NICKEL-CADMIUM SECONDARY SPACECRAFT CELLS

Ref: (a) National Aeronautics and Space Administration Purchase Order Number W11,252B
(b) NASA ltr BRA/VBK pad of 25 September 1961 w/BUWEPS first end FQ-1:WSK of 2 October 1961 to CO NAD Crane
(c) Preliminary Work Statement for Battery Evaluation Program of 25 August 1961

I. TEST ASSIGNMENT BRIEF

A. In compliance with references (a) and (b), evaluation of Jungners of Sweden 3.9 ampere-hour secondary spacecraft cells was begun according to the program outline of reference (c).

B. The object of this evaluation program is to gather specific information concerning secondary spacecraft cells. Information concerning performance characteristics and limitations, including cycle life under various electrical and environmental conditions will be of interest to power systems designers and users. Cell weaknesses, including causes of failure of present designs, will be of interest to suppliers as a guide to product improvement.

C. Sixteen 3.9 ampere-hour cells (manufacturer's rating) were furnished by SVENSKA ACKVMULATOR AKTIEBOLAGET JUNGNER, OSKARSHAMN, SWEDEN, to National Aeronautics and Space Administration (NASA).

II. CONCLUSIONS

A. From the results of this test, it can be concluded that:

1. The compression seals are satisfactory as evidenced by no leakers out of the 16 cells tested.

2. The capacity of the 16 cells was in the acceptable range of 3.90 to 4.26 ampere-hours.

III. RECOMMENDATIONS

A. It is recommended that these Jungner 3.9 ampere-hour "D" cells be accepted on the basis of the acceptance test results.

RESULTS OF ACCEPTANCE TESTS OF 3.9 AMPERE-HOUR NICKEL-CADMIUM SECONDARY SPACECRAFT CELLS MANUFACTURED BY SVENSKA ACKUMULATOR AKTIEBOLAGET JUNGNER OF SWEDEN

I. INTRODUCTION

A. On 3 August 1967, this activity began acceptance tests on 16 cells. These tests were completed on 24 August 1967.

II. TEST CONDITIONS

A. All acceptance tests were performed at an ambient temperature between 23° C and 27° C at existing relative humidity and atmospheric pressure and consisted of the following:

1. Phenolphthalein Leak Test.
2. Capacity Test.
3. Cell Short Test.
4. Immersion Seal Test.
5. Overcharge Test.
6. Internal Resistance Test.
7. Immersion Seal Test.

B. All charging and discharging was done at constant current (±5 percent). Cells were charged in series but discharged individually.

III. CELL IDENTIFICATION AND DESCRIPTION

A. As the cells were not identified by the manufacturer's numbers, this activity assigned numbers from 1 through 16.

B. The 3.9 ampere-hour "D" cell is cylindrical with an average diameter of 1.312 inches and an average overall length of 2.426 inches including the positive terminal. The average weight was 162.4 grams. Figure 1 is a photograph of the Jungner 3.9 ampere-hour "D" cell.

C. The cell container or can, and the cell cover are made of cold rolled steel. The can itself serves as the negative terminal. The positive terminal is a button extension of the positive plate tab through the center of the cover. The positive terminal is insulated from the "negative" cover by a compression seal.

D. These cells, rated by the manufacturer at 3.9 ampere-hours, were supplied in a partially discharged condition.

IV. TEST PROCEDURE AND RESULTS

A. Phenolphthalein Leak Test:

1. The phenolphthalein leak test is a determination of the condition of the welds and compression seal on receipt of the cells. This test was performed with a phenolphthalein spray indicator solution of one-half of one percent concentration.

(a) There were no signs of leakage on any of the 16 cells subjected to the leak test.

B. Capacity Test:

1. The capacity test is a determination of the cell capacity at the c/2 discharge rate, where C is the manufacturer's rated capacity, to a cutoff voltage of 1.00 volt per cell. The discharge was made after a 1-hour open circuit period following the 16-hour charge at the c/10 rate. A total of three capacity checks were made at this activity. The cells were discharged individually, but were recharged in series.

2. Since complete capacity data was not submitted by the manufacturer, it was not possible to compare the manufactuere's results with those of the activity. The individual cell capacities ranged from 3.90 to 4.26 ampere-hours for an average of 4.07 ampere-hours tc 1.00 volt. The cell capacities are tabulated in Table I. Characteristic 2-hour discharge curves are shown in Figure 2.

C. Cell Short Test:

1. The cell short test is a means of detecting slight shorting conditions which may exist because of imperfections in the insulating materials or damage to the element in handling or assembly.

2. Following completion of the third capacity discharge test, each individual cell was loaded with a resistor of value giving a c/1 to c/5 discharge rate and allowed to stand 16 hours with the resistor acting as a shorting device. At the end of 16 hours, the resistors were removed and the cells placed on open circuit stand for 24 hours. Any cell whose voltage did not recover to 1.15 volts or higher was rejected.

3. The open circuit cell voltages, 24 hours after removal of the shorting resistors, ranged from 1.16 to 1.19 volts for an average of 1.18 volts.

4. There were no rejects of any of the cells subjected to the cell short test. The voltage values for the 16 cells are shown in Table I.

D. Immersion Seal Test:

1. The immersion seal test is a means of detecting leakage of a seal or weld. The test was performed before and after the overcharge test sequence to determine the presence and cause of leaks.

2. The cells were placed in a bell jar container. A vacuum of 20 inches of mercury was held for 3 minutes. Cells discharging a steady stream of bubbles were considered rejects.

3. There were no rejects in the 16 cells subjected to the immersion seal test.

E. Overcharge Test:

1. The overcharge tests were performed to determine the steady state voltage at specified rates. The test specified a series of constant current charges at c/20, c/10 and c/5 rates, for a minimum of 48 hours at each charge rate or until the increase of the "on-charge" voltage was less than 10 millivolts per day.

2. The cells were monitored hourly throughout the test. Charging was to be discontinued on cells which exceeded 1.50 volts while on charge. There was no need to remove any cells from the charging sequence.

3. The steady state voltage of each cell at the end of each 48-hour charge rate test is shown in Table.I. Characteristic overcharge voltage curves are shown in Figure 3.

F. Internal Resistance Test:

1. .This test was performed to determine the internal resistance of the cells.

2. At the completion of the overcharge test; the cells were returned to the c/20 charging rate and given a short pulse (5-10 seconds) at a rate of c in amperes. The cell voltages, V1, immediately prior to the pulse; and V2, 5 milliseconds after the pulse, were read on a suitable recording instrument. A CEC high speed recorder (28.8 inches of tape per second) was used. The internal resistance of the cell in ohms was calculated according to the following formula:

$$R = \frac{V2 - V1}{Ic - Ic/20}$$

V1 and V2 are in volts, Ic and Ic/20 are in amperes.

3. The internal resistance value for each cell is shown in Table I. The values ranged from 8.3 to 22.2 milliohms.

TABLE I - NIFE 3.9 a.h.

CELL NUMBER	WEIGHT (GRAMS)	LENGTH (INCHES)	DIAMETER (INCHES)	CAPACITY TEST	CAPACITY TEST	CAPACITY TEST	CELL SHORT TEST	IMMERSION SEAL TEST	OVERCHARGE c/20	OVERCHARGE c/10	OVERCHARGE c/5	INTERNAL RESISTANCE TEST	IMMERSION SEAL TEST
1	163.7	2.416	1.312	4.16	3.96	3.80	1.18	OK	1.43	1.43	1.44	16.7	OK
2	163.4	2.426	1.310	4.14	4.00	3.90	1.17	OK	1.44	1.43	1.44	13.9	OK
3	156.1	2.420	1.312	4.04	3.94	3.80	1.17	OK	1.43	1.45	1.43	19.4	OK
4	160.7	2.420	1.312	4.04	3.94	3.80	1.18	OK	1.43	1.44	1.46	1 .4	OK
5	161.1	2.441	1.315	4.00	3.90	3.74	1.18	OK	1.43	1.44	1.44	22.2	OK
6	164.6	2.416	1.316	4.04	3.96	3.90	1.17	OK	1.43	1.44	1.44	13.9	OK
7	158.6	2.421	1.315	4.04	3.90	3.74	1.16	OK	1.43	1.44	1.44	13.9	OK
8	160.8	2.425	1.308	4.00	3.80	3.70	1.16	OK	1.43	1.44	1.43	13.9	OK
9	165.0	2.432	1.314	4.24	4.04	3.90	1.18	OK	1.45	1.47	1.49	19.4	OK
10	164.0	2.435	1.314	3.94	3.84	3.64	1.18	OK	1.43	1.48	1.48	22.2	OK
11	161.0	2.428	1.310	4.26	4.06	4.00	1.18	OK	1.43	1.45	1.47	19.4	OK
12	165.1	2.425	1.306	3.94	3.70	3.64	1.17	OK	1.43	1.43	1.45	16.7	OK
13	165.3	2.430	1.311	4.04	3.96	3.80	1.18	OK	1.44	1.46	1.44	8.3	OK
14	161.7	2.429	1.304	3.90	3.64	3.64	1.19	OK	1.43	1.43	1.44	13.9	OK
15	164.6	2.416	1.314	4.00	3.96	3.80	1.18	OK	1.44	1.43	1.44	16.7	OK
16	162.5	2.436	1.316	4.26	4.06	4.00	1.18	OK	1.43	1.44	1.44	16.7	OK

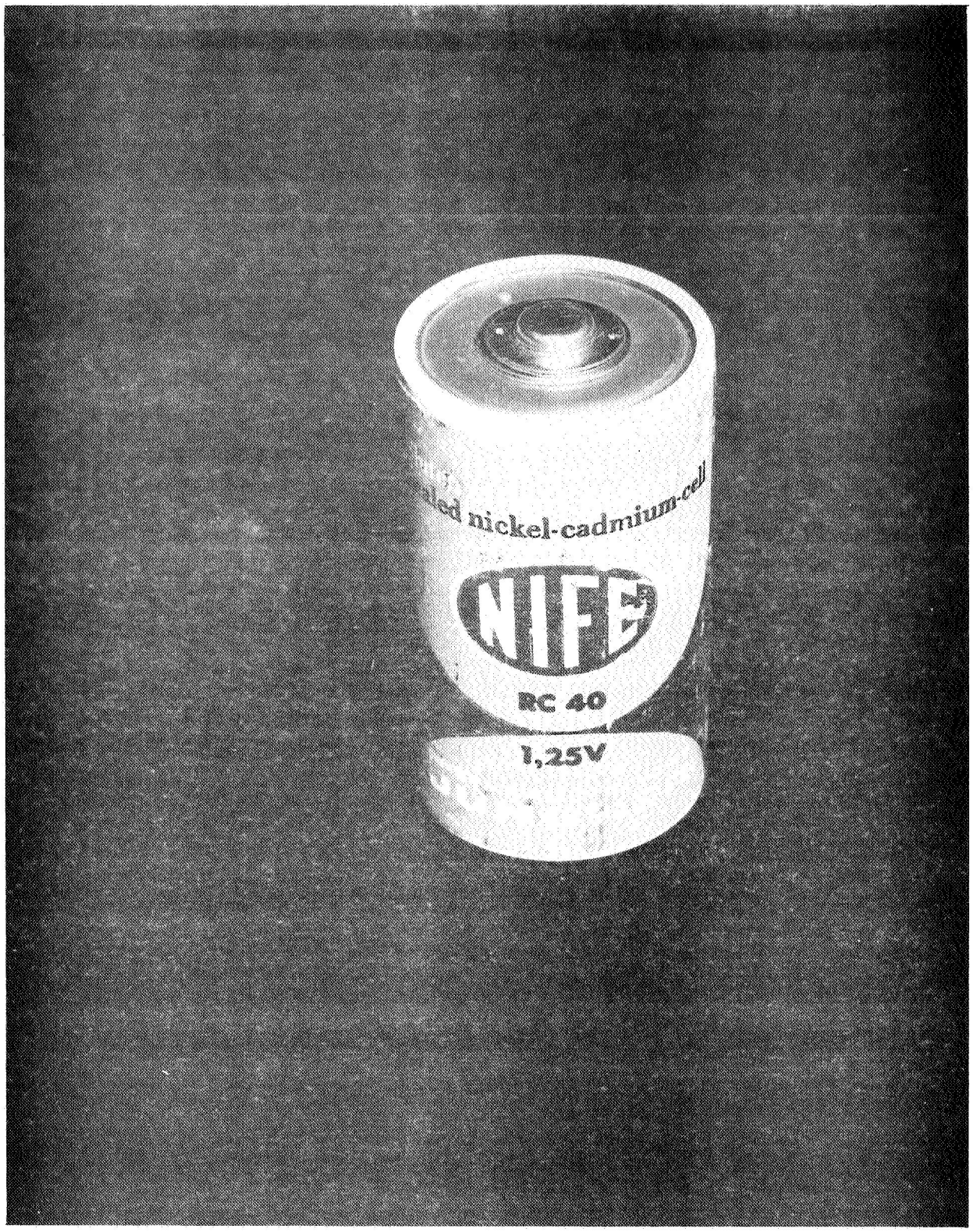

FIGURE 1

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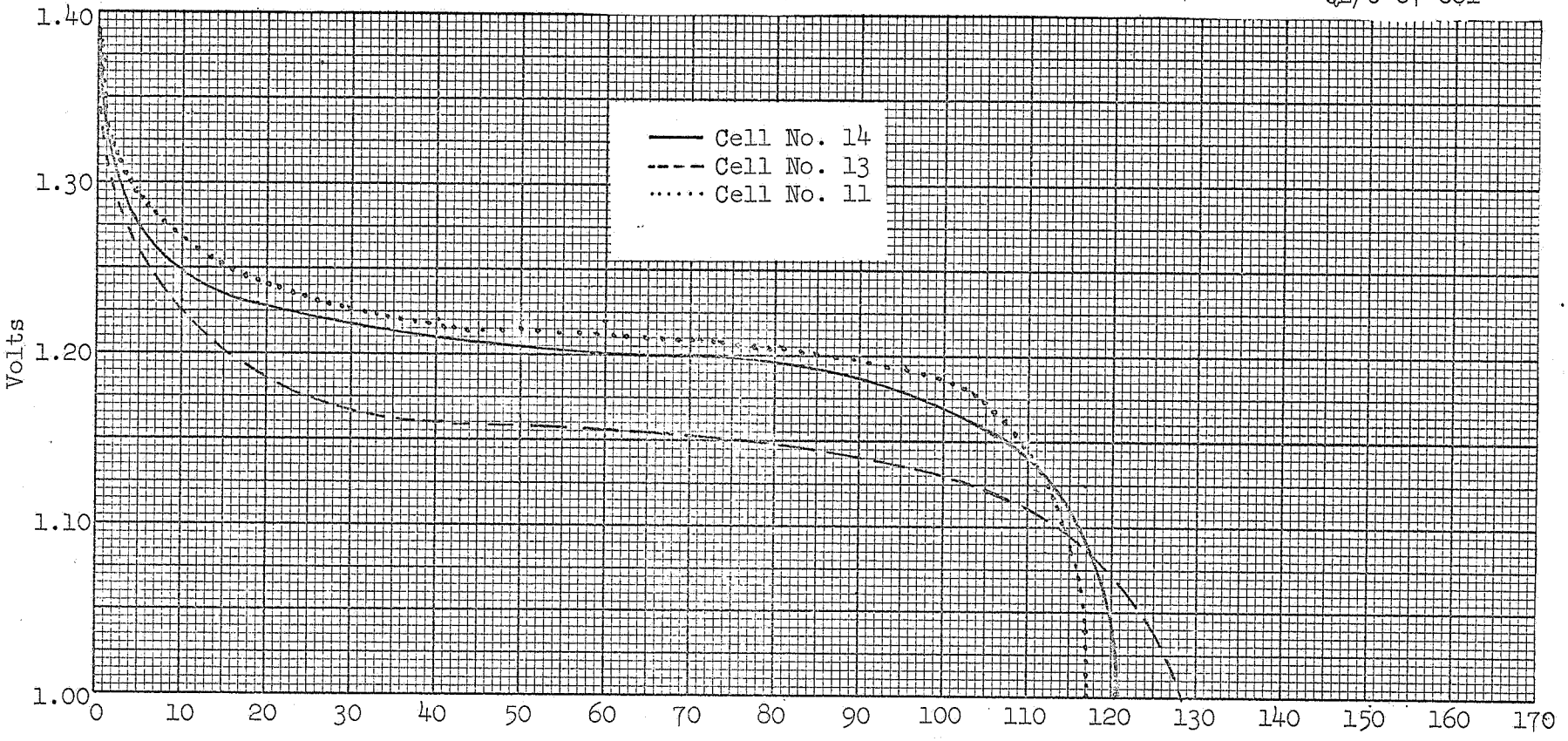
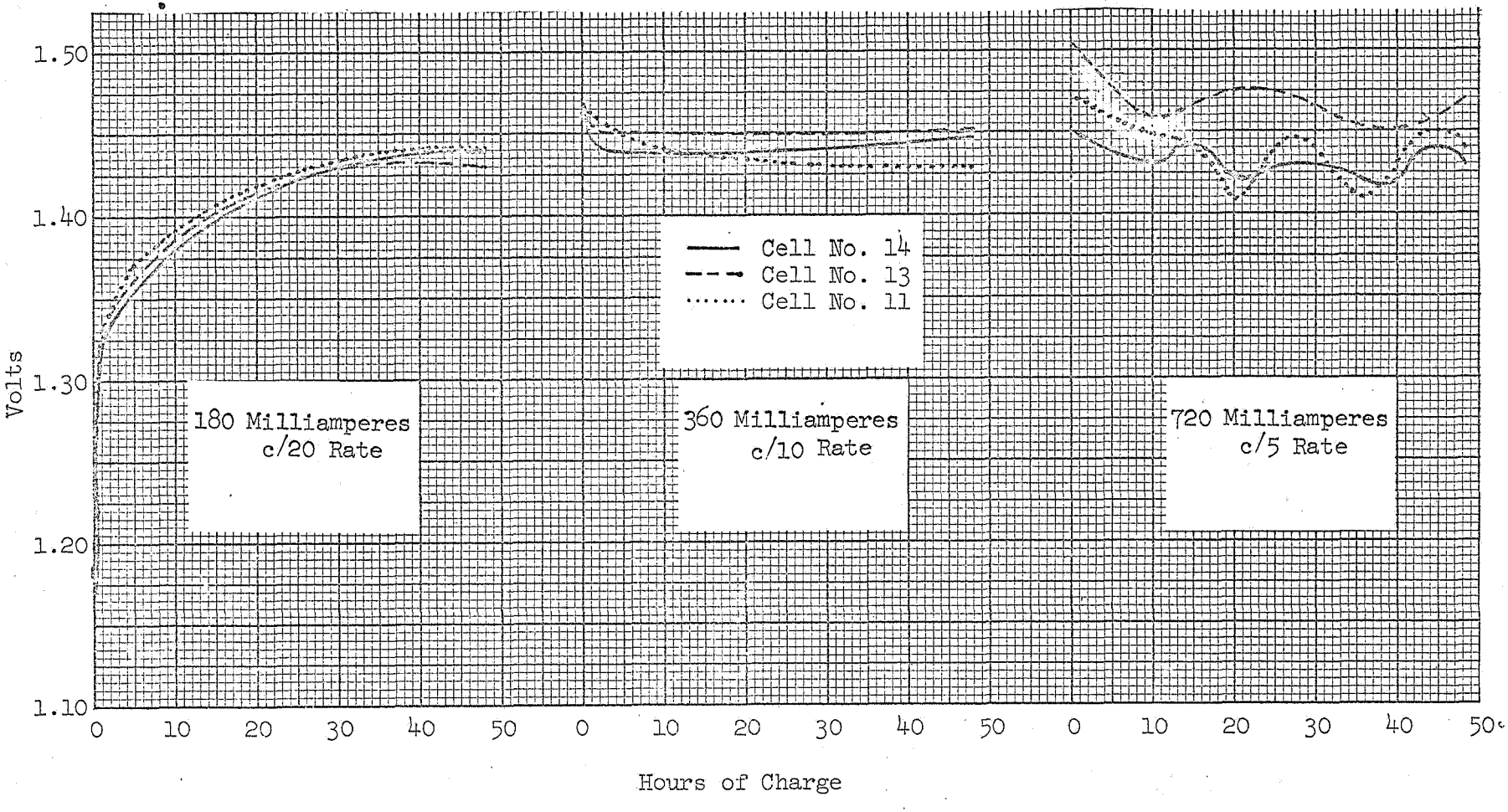


CHARACTERISTIC 2-HOUR RATE DISCHARGE CURVES

FIGURE 2



CHARACTERISTIC 48-HOUR OVERCHARGE CURVES

FIGURE 3

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